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A STUDY OF THE NUTRITION OF THE PIG; THE INFLUENCE OF THE GESTATION-LACTATION RATION ON THE PRENATAL AND POSTNATAL DEVELOPMENT OF THE PROGENY.

by

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UNIVERSITY OF ALBERTA

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FACULTY OF AGRICULTURE

The undersigned hereby certify that they have read and recommend to the Committee on Graduate Studies for acceptance a thesis on "A Study of the Nutrition of the Pig; the Influence of the Gestation-Lactation Ration on the Prenatal and Postnatal Development of the Progeny" submitted by Harold H. Draper, B.S.A., in partial fulfilment of the requirements for the degree of Master of Science.

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A STUDY OF THE NUTRITION OF THE PIG; THE INFLUENCE OF THE GESTATION-LACTATION RATION ON THE PRENATAL AND POSTNATAL DEVELOPMENT OF THE PROGENY.

Harold H. Draper
Department of Animal Science

A THESIS
submitted to the University of Alberta
in partial fulfilment of the
requirements for the degree of
MASTER OF SCIENCE

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TABLE OF CONTENTS

	Page
INTRODUCTION	1
REVIEW OF LITERATURE	2
SECTION I - REPRODUCTION PERFORMANCE	11
Object of Experiments	11
Experimental	11
Procedure - Series A	12
Results and Discussion - Series A	16
Procedure - Series B	21
Results and Discussion - Series B	23
Results and Discussion - Series A and B	26
SECTION II - PROGENY FEEDING TRIALS	31
Object of Experiments	31
Procedure	31
Results and Discussion	33
GENERAL DISCUSSION - SECTIONS I AND II	39
SUMMARY AND CONCLUSIONS	43
REFERENCES	45

Table of Contents

Page

Introduction 1

Review of literature 3

Section I - Theoretical aspects 11

Objects of experiments 11

Experimental 11

Procedure - Series I 12

Results and discussion - Series I 17

Procedure - Series II 31

Results and discussion - Series II 31

Summary of Section I 37

Section II - Practical aspects 39

Object of investigation 39

Procedure 39

Results and discussion 41

Summary and conclusions 54

Bibliography - Sections I and II 57

Appendix 62

Abstract 67

A STUDY OF THE NUTRITION OF THE PIG; THE INFLUENCE OF THE GESTATION-LACTATION RATION ON THE PRENATAL AND POSTNATAL DEVELOPMENT OF THE PROGENY

INTRODUCTION

Since the inception of feeding trial techniques several decades ago, many studies have been made of the nutrition of the pig from weaning to marketing age. A much smaller number of investigations have been conducted to obtain information on the influence of the diet of the sow during gestation and lactation upon the number of offspring and their viability. To date, no such comprehensive study has been reported from a Canadian source, and consequently the information at hand concerning the adequacy of common Canadian rations for reproductive functions of the brood sow is limited.

The chief barrier to carrying out reproduction studies with domestic animals is their time-consuming and costly nature. Data on a relatively large number of animals are desirable and the accumulation of such data involves extensive investments in breeding stock, housing and labor. The alternative to maintaining large numbers of breeding animals is to maintain a smaller number on a long-term basis, but this procedure involves a prolonged delay in obtaining reliable results.

[illegible]

[illegible]

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In view of the apparent need for a broad research program dealing with brood sow nutrition, a project was inaugurated at the University of Alberta in June, 1944, to obtain data on the reproduction performance of sows deprived of pasture and fed an unbalanced ration, as compared to that of sows fed a balanced ration including pasture. Pigs from these sows were utilized in comparative feeding trials to determine the effect of the gestation-lactation ration upon the growing-fattening performance of the progeny.

REVIEW OF LITERATURE

The value of good hay and pasture for brood sows has been recognized for many years. Alfalfa as a supplement to rations based on corn has been recommended to corn-belt hog producers in the United States by numerous authorities.

Morrison et al. (1) in 1928 observed that grains were unsatisfactory as the sole components of brood sow rations, and advocated alfalfa pasture during gestation. Martin (2) recommended including 10% of high quality legume hay in the ration when pasture was not available, but warned that the vitamin A potency of alfalfa hay was unreliable. However he cited this legume as capable of overcoming the deficiencies of a corn-tankage ration for sows.

In several trials Gardner and Freeman at Michigan found that good quality alfalfa hay could be utilized successfully to replace tankage as a supplement to a basal gestation ration of corn or mixed grains. The reproduction performance of breeding females, as measured by the weight, strength and numbers of pigs farrowed, was not materially different on tankage- or alfalfa-supplemented rations (3)(4). Equally satisfactory results were obtained when alfalfa hay was self-fed as when alfalfa meal constituted one-third of the basal diet (5).

Hogan and Johnson at Missouri conducted numerous trials designed to demonstrate the inadequacy of common gestation rations of the corn-soybean type and to find means of improving them (6)(7)(8). Hogan succeeded in raising to weaning age 81% of pigs from sows whose gestation ration had contained 15% alfalfa meal, as compared to only 51% from sows whose ration had contained 5% alfalfa meal (6). A later report showed that fresh cut forage or alfalfa meal reduced the mortality and number of abnormalities among pigs and increased the number weaned (9). The importance of pasture in supplying factors needed for optimum performance during lactation and for reducing the incidence of mortality was also demonstrated (10). Hogan, Johnson and Gahley (11) reported that over an eight year period thirty-eight sows weaned 53% of the live pigs they farrowed when fed the following gestation-lactation ration: yellow corn 77, tankage 10, linseed oil meal 5, alfalfa meal 5, salts 2 and cod liver oil 1. Many suckling pigs were stricken

with skin lesions, muscular incoordination, fatty livers, diarrhoea or hemorrhage. Supplementation of the above ration with niacin, thiamin and riboflavin, plus molasses and soybean oil as sources of pantothenic acid and vitamin E respectively, considerably increased the percentage of pigs weaned as well as their weaning weights, and decreased the number of abnormalities (12). The noticeable incidence of leg weakness, however, led Hogan and McRoberts to conclude that a vitamin(s) other than those supplied was deficient in the common feedstuffs used in swine rations.

Two reports dealing with the effect of nutrition on reproduction processes in the pig and rat have been published recently by Ross, Phillips and Bohstedt of the University of Wisconsin. A common basal ration of the following composition was fed to gilts during growth, gestation and lactation: ground yellow corn 76.35, soybean oil meal 17.50, ground alfalfa hay 5.00, iodized salt 0.50 and calcium carbonate 0.65 percent. Invariably the gilts failed to suckle their young sufficiently to allow normal growth, though there appeared to be no inhibition of the reproductive function prior to farrowing (13). The young pigs became thin and weak, and death ensued in many cases. The inclusion of 15% alfalfa meal in the maternal diet materially increased the vigor of the offspring. The basal ration, when fed to rats, produced a high incidence of intrauterine hemorrhage and fetal death, but when supplemented with alfalfa at the 15% level it permitted normal reproduction and lactation. Likewise a Skelly-B extract of alfalfa, plus casein,

pantothenic acid, riboflavin and pyridoxine, gave excellent results, though the extract alone was ineffective.

In a later study by the same workers, the record of gilts receiving a similar basal ration plus 15% alfalfa was compared to that of gilts receiving only 5% alfalfa supplement. Twice as many pigs averaging 25% heavier were weaned by the first group (14). The deficiencies of the 5% alfalfa ration, as assessed from the number of abnormalities at birth, were more acute in the second generation. Supplementation with wheat bran, middlings, fishmeal, tankage, brewers' yeast or molasses during the late gestation period failed to improve the reproduction performance.

Cunha, Ross, Phillips and Bohstedt (15) continued these investigations by observing the effect of adding various supplements to the basal ration. The addition of either choline, crystalline riboflavin or 1% B-Y riboflavin supplement proved ineffective and, in some cases, detrimental. Adding 2% B-Y riboflavin supplement produced an improvement but did not eliminate abnormalities. Normal reproduction was obtained by supplementing the basal ration with either 10% alfalfa meal or soybean lecithin plus pyridoxine. The soybean lecithin contained about 3% inositol and 3% choline. The investigators had previously found that inositol was somewhat beneficial in reproduction and lactation rations for swine.

Of the sows maintained on the basal ration during growth prior to this experiment, fifty percent were sterile

and the reproduction record of the remainder was extremely poor regardless of the gestation ration fed. This observation led the authors to conclude that the ration sows receive during growth markedly influences their subsequent performance in reproduction and lactation.

Rats reproduced normally on the basal diet plus liver, inositol, choline and pyridoxine, but not on the basal ration plus all the known B-complex vitamins including folic acid and biotin. From the studies with swine and rats, these workers concluded that the unknown factor or factors necessary for normal reproduction were present in soybean lecithin and liver.

Extensive investigations were conducted by the Illinois workers Fairbanks, Krider and Carroll to determine the value of adding various supplements to a corn-soybean lactation ration. Initial tests indicated that the addition of 6% dried corn distillers' solubles to such a ration produced no appreciable improvement in the weaning record (16).

Striking results were obtained by Krider et al. (17) from feeding a basal ration of the following composition to gilts in drylot during the growth, gestation and lactation periods: ground yellow corn 83, soybean meal 8, tankage 5, fish meal 2, limestone 0.5, steamed bone meal 0.5, iodized salt 0.5 and fortified cod liver oil 0.5. These results, together with those obtained from the addition of various supplements, are summarized as follows:

Ration	Pigs weaned
(1) Basal	13% and 7% (two years)
(2) Basal + 6% dried corn distillers' solubles	48%
(3) Basal + 12% dried corn distillers' solubles	41%
(4) Basal + crystalline vitamins*	50%
(5) Basal + 6% dried corn distillers' solubles + 4% alfalfa meal	85%
(6) Basal + 10-12% alfalfa meal	83% and 82% (two years)

*Thiamin, riboflavin, niacin, choline, pyridoxine and pantothenic acid.

These findings bear out previous work with alfalfa and support the conclusion of Cunha et al. (15) that the deficient factor(s) is not one of the known B-complex vitamins.

Further trials were conducted to determine the value of adding various supplements to the above ration during gestation (18). All sows were placed on the basal ration during lactation to test the residual effect of the gestation diet. The results are tabulated below:

Gestation ration	Average No. pigs farrowed	Average No. pigs weaned
Trial A		
Basal	6.2 (13% dead)	0.8
Basal + 6% dried corn distillers' solubles	7.1	3.0
Basal + 12% "	10.1	4.0
Basal + 12% alfalfa meal	10.0	8.3
Trial B		
Basal	7.5 (66% dead)	0.5
Basal + crystalline vitamins*	9.3	4.6
Basal + 6% dried corn distillers' solubles + 4% alfalfa meal	9.0	7.7
Basal + 10% alfalfa meal	9.3	7.7

*Thiamin, riboflavin, niacin, pantothenic acid, pyridoxine and choline.

Region	Type series
(1) Basal	[illegible]
(2) Basal + C4 detail zero distiffere' molecule	[illegible]
(3) Basal + C2a cycles occur distiffere' molecule	[illegible]
(4) Basal + cyprodilin vibrations	[illegible]
(5) Basal + 5% prism zone (delifiere' molecule + C2 alkalic mast	85%
(6) Basal + 10-15% alkalic mast	85% and 90% (see below)

Methods, ribofilavin, diuretic, dentine, pyridoxine and pantothenic acid.

Yeast findings bear out previous work on the alkalic and suggest the conclusion of Davis et al. (15) that the deficient factor(s) is not one of the known B-complex vitamins.

Various extracts were condensed to determine the value of adding various supplements to the basic medium during incubation to test the continued effect of the particular fac-

The results are summarized below:

Supplementation tested	Average no. cells produced	Average no. cells/ml
Type A		
Basal	[illegible]	[illegible]
Basal + 5% yeast extr	[illegible]	[illegible]
" + 1%	[illegible]	[illegible]
" + 2%	[illegible]	[illegible]
" + 4% alkalic mast	[illegible]	[illegible]
Type B		
Basal	[illegible]	[illegible]
Basal + cyprodilin vitamins	[illegible]	[illegible]
Basal + 5% yeast extr [illegible]		
molecule + 1% alkalic mast	[illegible]	[illegible]
Basal + 1% alkalic mast	[illegible]	[illegible]

These data indicate that storage of known or unknown factors was great enough to be manifested in significant differences in the number of pigs that survived to weaning. Alfalfa was the most effective supplement to the basal ration, though the corn solubles improved the breeding efficiency of the sows and the vigor of the young pigs. The residual effect of the ration supplemented with a mixture of crystalline vitamins was not as pronounced as that of the rations supplemented with the natural vitamin-carriers.

The effects produced by adding condensed fish solubles to the corn-soybean basal ration during gestation and lactation, or by giving access to rye pasture during these periods, were reported by Krider et al. (19). Results accruing from feeding the basal ration were similar to those already described, while the fish solubles, at 3% and 6% levels, and the rye pasture, produced an improvement in the reproduction performance to a level somewhat below that attained on the alfalfa-supplemented rations previously reported. Gross abnormalities similar to those reported elsewhere occurred among pigs whose dams were fed the basal ration.

In a repetition of this experiment, Krider and associates (20) found that the deficiency (or deficiencies) of the basal ration was corrected by supplementing it with rye pasture, 10% alfalfa meal or either 2% or 4% condensed fish solubles. These results were essentially the same as those obtained in the first experiment, except that in this trial the fish solubles appeared to be equal to alfalfa as a source of the missing factor(s).

In attempts to identify the unknown ingredients, Krider et al. added all the known B-vitamins to the corn-soybean ration (21). The basal ration consisted of ground yellow corn 72.5, soybean meal 25, fortified cod liver oil 0.5, mineral mixture 2, plus the crystalline vitamins thiamin, riboflavin, niacin, pantothenic acid, pyridoxine and choline. This mixture was fed to gilts during gestation and lactation. Their reproduction performance as measured by the percentage of pigs weaned was as follows:

Ration	Pigs weaned
Basal	69%
Basal + pyracin + para-amino-benzoic acid + inositol + biotin + alpha-tocopherol + vitamin K	32%
Basal + 10% dehydrated alfalfa meal	97%
Basal + AB liver extract	82%
Basal + folic acid concentrate	84%
Basal + Cerogras	41%

No explanation was offered for the detrimental effect produced by adding the assortment of vitamins. Apparently the alfalfa and liver contained important factors other than the vitamins added to the basal ration. Although the addition of the folic acid concentrate did not improve weaning weights significantly, the pigs from sows so fed were thriftier and more vigorous than pigs from sows fed the basal ration.

The essentiality of an unknown factor(s), or of one of the lesser known B-complex vitamins, for successful reproduction and lactation in swine was effectively demonstrated by Ensminger et al. (22) by means of purified gestation diets.

The basal diet contained casein, sucrose, lard and minerals, plus the six common B vitamins thiamin, riboflavin, niacin, pantothenic acid, pyridoxine and choline. When this ration was fed for 140 days before farrowing, complete lactation failure followed, but when it was fed for only 52 days prior to farrowing, a good reproduction record resulted, indicating the storage of essential factors before the experiment.

With reference to reports cited in the literature on the beneficial supplementary value of liver, dried corn distillers' solubles and fish solubles in swine rations, it is of interest to note that one or more unidentified growth factors for chicks have been shown to exist in each of these materials (24)(25)(26). In addition, a chick growth factor(s) exists in cow manure (27), and it would be of special interest to know the importance of this factor in the nutrition of sows under farm conditions.

Fortunately, reproduction difficulties of the severity of those reported by American obeervers are not normally encountered by Canadian swine producers who feed reasonably well-balanced rations based on the common coarse grains. From the standpoint of their ability to supply the known essential nutrients in the required amounts, the basal corn-soybean gestation diets described as 'inadequate' by many workers appear equal, or superior, to those used extensively, and with considerable success, in Canada. The chief difference between these two types of rations lies in the grains used, and it appears that corn, in comparison with barley and oats, is deficient

in one or more factors essential to successful reproduction in the pig.

While the use of pasture and hay in brood sow feeding has been recommended for many years, relatively large numbers of Canadian swine producers continue to raise pigs under conditions approaching continuous drylot feeding. Although brood sow nutrition appears to be less hazardous for the mixed grain feeder than for the corn grain feeder, it appears likely that the former also may suffer losses from the absence of green vegetation in the ration. To date no comprehensive study has been made of the character or magnitude of these probable losses. It was to study these points that the project described in the ensuing report was undertaken.

SECTION I. REPRODUCTION PERFORMANCE

Object of Experiments

This study was conducted to obtain data on the performance of sows deprived of pasture and fed an unbalanced ration as compared to that of sows fed a balanced ration including pasture.

Experimental

The experiments subsequently described are divided into two series, A and B, according to the nature of the experimental ration. In Series A, comprised of five experiments

(Nos. 200, 200B, 208, 208B and 215), the experimental ration contained no greenfeed, whereas in Series B, comprised of two experiments (Nos. 218 and 221), it contained alfalfa meal. The control ration was similar for both series. Beginning with Experiment #208B the original breeding females were gradually replaced with second generation stock.

Procedure - Series A

Experiment #200 - Summer 1944

Two groups of four two-year-old purebred Yorkshire sows of similar breeding were used in this experiment. They and their dams had previously been maintained on what is commonly considered to be a good practical ration made up of coarse grains, mixed supplement, and pasture or alfalfa hay plus fish oil. The sows were fed the following rations during gestation and lactation:

Control Group

(a) while on pasture:

Oats	47
Barley	47
Mixed supplement*	6
	100

(b) while in drylot:

Oats	44
Barley	44
Mixed supplement*	12
	100

Fish oil (1500A-200D) - 15 c.c. per sow per day

Experimental Group

Oats	49
Barley	49
Iodized salt**	1
Ground limestone	1
	100

*Mixed Supplement:

Tankage	50
Linseed oil meal	25
Alfalfa meal	15
Ground limestone	5
Iodized salt	5
	100

**Iodized Salt - 4 oz. KI per 100 lbs. salt.

The control group were fed according to the usual university herd regime which included cereal grain or rape pasture for a period of approximately four months during the summer. The experimental group were subjected to continuous drylot feeding in vegetation-free yards during the gestation period. Sows of both groups were moved into the main piggery for farrowing and the first three or four weeks of lactation, where they were maintained on the rations outlined. They were then transferred outside to colony houses situated in enclosed yards.

Control Group

(a) While on Ration:

Dose	47
Delay	40
Mixed Responses	3
	100

(b) While in Urine:

Dose	44
Delay	40
Mixed Responses	16
	100

Plus oil (15gm.-cum.) - 75 c.c. per cow per day

Experimental Group

Dose	43
Delay	55
Isolated Saliva	1
Mixed Responses	1
	100

Fixed Conditioned:

Tendons	50
Pressed Sit Meat	25
Alfalfa Meal	15
Normal Limestone	5
Isolated Salt	5
	100

Isolated Salt - 5 oz. Ei per 100 lbs. Salt.

The control group were fed according to the usual university need regime which included cereal grain in some portions (in a period of approximately four months during the summer. The experimental group were subjected to conditions similar to existing in extension-free yards during the exhibition period. Some of both groups were fed into the main plant [illegible] and the first three or four weeks of lactation, while all were maintained on the regions outlined. Only meal from [illegible] outside to calves showed signs in unfavourable trend.

All young pigs were dosed with 15 grains of reduced iron at 7, 14 and 21 days of age as protection against nutritional anemia. With each dose they were also given approximately 3 c.c. of fish oil (1500A-200D).

Data were collected on the breeding, farrowing and lactation performance of the sows and the weaning record of the young pigs.

Experiment #200B - Winter 1944-45.

Owing to the critical labor situation, it was not possible to maintain the two lots of sows on the rations originally outlined. Consequently both groups were fed the following ration during gestation:

Oats	60
Barley	34
Mixed supplement*	6
	100

*As for Experiment #200.

At farrowing the groups were returned to their respective rations as outlined for Experiment #200. Apart from this alteration, the procedure of that experiment was duplicated.

Experiment #208 - Summer 1945

As for Experiment #200.

Experiment #208B - Winter 1945-46

Three second-generation gilts were selected from the second litters of each original group. These were added to their respective lots and maintained according to the procedure of Experiment #200, with the exception that during the winter the control gilts were self-fed alfalfa hay in addition to the regular ration.

Experiment #215 - Summer 1946

Two additional second-generation gilts were selected from the third litters of the original sows. These gilts and the two remaining control and experimental sows from Experiment #200 were continued under the conditions of that experiment.

In summary, the control group of Series A were fed a ration considered adequate with respect to protein, minerals, vitamins A and D, and any other factors afforded by pasture, whereas the experimental group were fed a mixture consisting of coarse grains, calcium supplement and iodized salt, a ration considered deficient or borderline in protein and vitamin D, definitely lacking in vitamin A, and possibly wanting in other unknown nutrients obtained from pasture.

The crude protein content of the rations of both groups varied considerably with different sources of coarse grains, but analyses indicated that on an air-dry basis the protein content of the drylot ration for the control group ranged from

14.0-15.0%, while that of the experimental group varied from 10.5-11.5%.

Results and Discussion - Series A

The farrowing and weaning records of the experimental and control groups are summarized in Tables I and II.

TABLE I

Farrowing Record - Control vs. Experimental Sows.

	No. sows bred	No. sows farrowed	Total no. pigs born		Av. no. born*		Av. birth weight, lbs.
			Alive	Dead	Alive	Dead	
Experiment #200							
Control	4	3	38	1	12.7	0.3	2.8
Experimental	4	4	40	1	10.0	0.3	2.5
Experiment #200B							
Control	4	4	48	2	12.0	0.5	2.5
Experimental	4	3	27	2	9.0	0.7	2.7
Experiment #208							
Control	4	3	33	2	11.0	0.7	2.5
Experimental	4	4	38	-	9.5	-	2.6
Experiment #208B							
Control	7	7	61	4	8.7	0.6	2.4
Experimental	7	7	52	4	7.4	0.6	2.7
Experiment #215							
Control	6	5	62	-	12.4	-	2.4
Experimental	6	6	43	3	7.2	0.5	2.8
Totals and Means							
Control	25	22	242	9	11.0	0.4	2.5
Experimental	25	24	200	10	8.3	0.4	2.7

*Basis no. sows farrowed.

Table I

Interfering bacteria - Control vs. Experimental Zone.

	No. Used	No. Recovered	Total No. Plaque Forming Units	No. Zone Lysis	% Zone Lysis
Experiment #1000					
Control	4	81	1	1.7	1.2
Experimental	4	40	1	10.0	2.5
Experiment #1001					
Control	4	64	2	6.0	3.1
Experimental	4	57	2	4.0	3.5
Experiment #1002					
Control	4	24	2	12.0	8.3
Experimental	4	20	-	0.5	-
Experiment #1003					
Control	7	61	4	6.7	6.6
Experimental	7	44	4	7.4	9.1
Experiment #1014					
Control	5	62	-	12.4	-
Experimental	5	40	2	7.2	5.0
Totals and Means					
Control	25	286	9	14.0	3.1
Experimental	25	200	10	8.2	5.0

Totals do not include Experiment #1000.

TABLE II

Weaning Record - Control vs. Experimental Sows

	No. pigs born alive		No. weaned		%	Age at weaning,	Av. Weaning
	Total	Mean*	Total	Mean*	Weaned	days	Weight, lbs.
Experiment #200							
Control	38	12.7	28	9.3	58	56	26.7
Experimental	40	10.0	24	6.0	40	56	23.1
Experiment #200B							
Control	48	12.0	41	10.3	85	59	27.9
Experimental	27	9.0	17	5.7	63	54	23.6
Experiment #208							
Control	33	11.0	19	6.3	58	55	23.1
Experimental	38	9.5	11	2.8	29	56	21.4
Experiment #208B							
Control	61	8.7	42	6.0	69	51	26.0
Experimental	52	7.4	34	4.9	65	59	30.5
Experiment #215							
Control	62	12.4	50	10.0	81	62	24.4
Experimental	43	7.2	24	4.0	56	63	29.5
Totals and Means							
Control	242	11.0	180	8.2	74	57	25.9
Experimental	290	8.3	110	4.6	55	58	26.7

*Basis no. sows farrowed.

Few breeding difficulties were encountered during these experiments and the experimental ration appeared to have no deleterious effect upon the breeding performance. One control sow from Experiment #200 and one from Experiment #208 aborted at the 88th and 58th day of gestation respectively, and another control sow from Experiment #215 proved to be sterile. In the initial case abortion ensued after a fight between two of the sows. Among the experimental group, one sow from Experiment

#200B failed to conceive after two services but became pregnant after a single service in the following season.

As indicated in Table I, litters farrowed by the control sows averaged 2.7 more live pigs than those farrowed by the experimental group. In accordance with the smaller litters, the birth weights of the experimental group pigs were somewhat superior. However, as evidence of the inability of the experimental ration to meet the demands of lactation, by weaning age the disparity in litter size had increased to 3.6 pigs. The control sows weaned 74% of their pigs as compared to 55% for the experimental sows. While this figure for the control group is not considered satisfactory, it indicates the superior ability of these sows to successfully raise their young. Nevertheless, the progeny of the test group which survived to weaning age were as heavy at that time as those from the control group.

In spite of the lack of feeding oil in the experimental ration, no apparent manifestations of vitamin A deficiency, such as a high incidence of malformations or of stillborn pigs, were observed. To what degree, if any, the weakness of many of the experimental pigs and their susceptibility to secondary infections were attributable to a deficiency of this vitamin, is questionable.

Feed records for both groups of sows in comparable drylot periods indicated an average daily consumption of 5.7 and 6.4 lbs. of feed during gestation, and 15.0 and 13.5 lbs. during lactation for the control and experimental sows respectively. An estimate of the daily nutrient consumption for the two groups

is given in Table III which was compiled from the Morrison values for total digestible nutrients, calcium and phosphorus, and analytical values for protein.

TABLE III

Average Daily Nutrient Consumption
During Gestation and Lactation
- Control vs. Experimental Sows
in Drylot - Series A

	Control	Experimental	Recommended Allowance
Gestation Period			
T.D.N. (lbs.)	4.20	4.71	4.0 - 5.0*
Crude protein (lbs.)	.83	.70	0.9**
Digestible protein (lbs.)	.65	.55	.53 - .60*
Calcium (gm.)	18.9	13.2	16.4**
Phosphorus (gm.)	14.7	10.1	10.9**
Lactation Period			
T.D.N. (lbs.)	11.1	9.9	8.5 -10.0*
Crude protein (lbs.)	2.18	1.49	1.5 - 2.3**
Digestible protein (lbs.)	1.70	1.18	1.22-1.29*
Calcium (gm.)	49.0	27.7	27 - 41**
Phosphorus (gm.)	38.8	21.3	18 - 27**

*Morrison values (28).
**National Research Council (U.S.A.) values (29).

The National Research Council recommendations for protein appear to be considerably higher than those of Morrison. According to the latter, the control ration was adequate with respect to protein and T.D.N., while the experimental ration was slightly deficient in digestible protein during lactation. It should be noted that the protein content of the grain varied significantly, so that it seems certain that the experimental ration was deficient in this nutrient for substantial periods of time. In addition, the quality of cereal protein for purposes of gestation

and lactation is questionable.

The experimental gestation ration failed to meet the National Research Council recommendations for calcium, but concurred with the specification of Hogan (30) that the gestation diet should contain at least 0.4% calcium. In this case calcium constituted 0.46% of the ration.

Procedure - Series B

Experiment #218 - Winter 1946-47

Data accumulated from Series A experiments indicated that the reproduction trends of the respective groups were definitely established and that no further information of essential importance was likely to accrue from a continuation of the nutritional regime of Experiment #200. In view of the many reports indicating the value of alfalfa as a supplement to corn-soybean gestation-lactation rations, the ensuing experiments were designed to determine the ability of alfalfa meal, when fed as part of the experimental ration during pregnancy and lactation, to improve the farrowing and weaning performance of the experimental lot. This group now consisted of five second-generation sows from the third and fourth litters of the original stock. One sow had already farrowed twice during Series A, two had farrowed once, and two were being bred for the first time. Their alfalfa-supplemented ration is outlined below:

Oats	43
Barley	43
Alfalfa meal	12
Ground limestone	1
Iodized salt	1
	100

The control group was comprised of two first-generation and six second-generation sows. The control ration and management practices of Experiment #200 were retained.

Experiment #221 - Summer 1947

This experiment was a continuation of Experiment #218. The experimental group ration was amended to contain 16% alfalfa meal instead of 12%:

Oats	41
Barley	41
Alfalfa meal	16
Ground limestone	1
Iodized salt	1
	100

The two original sows remaining in the control group were removed prior to Experiment #221, leaving five and four sows respectively in the control and experimental lots.

The alfalfa meal used in these rations was of medium quality and contained approximately 14.0% protein. The protein content of the experimental group ration for Series B was slightly greater than that for Series A; the protein range as estimated from intermittent analyses was 11.0-12.0% on an air-dry basis.

Results and Discussion - Series B

The farrowing and weaning data from Experiments #218 and #221 are summarized in Tables IV and V. Averages are on the basis of the number of sows farrowed.

TABLE IV

Farrowing Record - Control vs. Experimental Sows

	No. sows bred	No. sows farrowed	Total no. pigs born		Av. no. born		Av. birth weight, lbs.
			Alive	Dead	Alive	Dead	
Experiment #218							
Control	8	7	77	9	11.0	1.3	2.6
Experimental	5	5	46	6	9.2	1.2	2.4
Experiment #221							
Control	5	5	60	-	12.0	-	2.8
Experimental	4	4	40	1	10.0	0.3	2.8
Totals and Means							
Control	13	12	137	9	11.4	0.8	2.7
Experimental	9	9	86	7	9.6	0.8	2.6

TABLE V

Weaning Record - Control vs. Experimental Sows

	No. pigs born alive		No. weaned		% Weaned	Age at weaning, days	Av. weaning weight, lbs.
	Total	Mean	Total	Mean			
Experiment #218							
Control	77	11.0	43	6.1	56	59	28.6
Experimental	46	9.2	17	3.4	37	57	22.6
Experiment #221							
Control	60	12.0	40	8.0	67	57	22.0
Experimental	40	10.0	28	7.0	70	56	17.9
Totals and Means							
Control	137	11.4	83	6.9	60	58	25.4
Experimental	86	9.6	45	5.0	52	56	19.7

In connection with Experiment #218 it should be noted that one control sow farrowed six dead and sixteen live pigs of which only two survived. This exceptionally large litter therefore caused a disproportionate increase in the average number of pigs born alive for the group and a similar decrease in the average number weaned. The same sow which failed to conceive in Experiment #215 also failed to become pregnant in Experiment #218 and was consequently marketed.

Inspection of Tables IV and V reveals a wide variation between the two experimental lots of Series B in the average numbers of pigs weaned and their weaning weights. The mortality rate during lactation among the pigs from Experiment #218 was exceedingly high, whereas among those of Experiment #221 it was greatest after weaning. In terms of percentages of pigs marketed, 33% of the pigs from Experiment #218 reached market age as compared to 42% of those from Experiment #221.

In so far as a comparison is possible from an average of the two seasons' data acquired since the supplementation of the experimental ration with alfalfa meal, there appears to have been no improvement in the reproduction record of the sows except with respect to litter size. The results obtained from five farrowing seasons in Series A and two seasons in Series B are summarized in Table VI.

TABLE VI

Reproduction Record - Experimental Sows - Series A and B

	No. litters	Av. no. pigs born alive	Av. birth weight (lbs.)	Av. no. weaned	% Weaned	Av. weaning weight (lbs.)
Series A	24	8.3	2.7	4.6	55	26.7
Series B	9	9.6	2.6	5.0	52	19.7

The average difference of 1.3 live pigs born per litter between the experimental sows of Series A and Series B was highly significant (beyond the 1% point) according to Student's *t* test for unpaired values ($t = 3.76$). This indicates that the addition of alfalfa to the experimental ration caused a 'real' improvement in the farrowing record of the sows.

Although the losses between farrowing and weaning averaged 4.6 pigs per sow for Series B as compared to 3.7 for Series A, the average numbers of pigs weaned by the Experiment #221 sows shows a considerable improvement over that of the Series A sows and those of Experiment #218. However, the average weaning weight for these pigs was the lowest of all the groups and the post-weaning losses were the highest. Further data are required before definite conclusions can be drawn, but judging from the results of these two experiments the alfalfa meal was unable to remedy the lactation failure caused by continuous drylot feeding of a mixture of oats and barley supplemented with calcium and iodized salt.

With reference to the very low weaning weights of the experimental group pigs of Experiment #221 it is of interest

to note that the average daily feed consumption of their dams during lactation was only 10.6 lbs. The alfalfa meal supplement did not appear to stimulate the appetites of the sows, and the average daily intake of protein and total digestible nutrients was considerably below the Morrison standards.

Results and Discussion - Series A and B

The data derived from the respective groups for the two series of experiments are summarized in Tables VII and VIII.

TABLE VII

Farrowing Record - Control vs. Experimental Sows

No. sows bred	No. sows farrowed	Total no. pigs born		Av. no. born		Av. birth weight (lbs.)
		Alive	Dead	Alive	Dead	
Control group - Series A and B						
38	34	379	18	11.1	0.5	2.6
Experimental group - Series A						
25	24	200	10	8.3	0.4	2.7
Experimental group - Series B						
9	9	86	7	9.6	0.8	2.6

so were those who received Test Procedure C. Only those during Interaction who were 10.0 hrs. The ability and readiness all did appear to distinguish the Interview C. The some, but the average ratio figure of scarcity for total Test Procedure was greatly below the Interview Procedure.

Results and Discussion - Part 2 and 3

The data collected from the experimental groups in the two parts of experiments are summarized in Tables VII and VIII.

Table VII

Summarized Record - Control vs. Experimental Data

No. Items Read	No. Items Recalled	Time Taken	Total No. Items Recalled	Ave. Time	Ave. Items Recalled
Control Group - Section 2 and 3					
30	24	30"	24	1'.1	24.0
Experimental Group - Section 2					
25	21	30"	10	1'.1	10.4
Experimental Group - Section 3					
0	0	30	7	1'.1	0.6

TABLE VIII

Weaning Record - Control vs. Experimental Sows

No. pigs born alive		No. weaned		%	Age at weaning,	Av. weaning
Total	Average	Total	Average	Weaned	(days)	weight (lbs.)
Control group - Series A and B						
379	11.1	263	7.7	69	57	25.6
Experimental group - Series A						
200	8.3	110	4.6	55	58	26.7
Experimental group - Series B						
86	9.6	45	5.0	52	56	19.7

It has already been noted that the addition of alfalfa meal to the ration of the experimental lot produced a significant increase in the number of live pigs born per litter. An analysis of variance for litter size for the control group, Series A and B, and the experimental group, Series A, is presented in Table IX.

TABLE IX

Analysis of Variance for Litter Size

Variance due to	D.F.	Sum of Squares	Variance	F	5%	1%
Between sows	19	35.65	1.88	0.22	2.02	2.76
Between groups	1	111.39	111.39	12.91**	4.10	7.35
Within sows	38	327.94	8.63			
All causes	38	474.98				

**Significant beyond 1% point.

Total	Control	Experimental	Control	Experimental
Control group - Series A and B				
320	14.1	109	7.7	81
Experimental group - Series A				
200	8.3	110	6.0	75
Experimental group - Series B				
86	7.	45	5.0	25

TABLE IX

Analysis of Variance for Litter Size

Variance due to	d.f.	Sum of Squares	Variance	F	.05	.01
Between sows	11	16.85	1.53	1.25	1.90	2.70
Between groups	1	111.39	111.39	91.14	4.10	7.39
Within sows	50	427.	1.22			
All causes	62	555.24				

significance beyond the 1% point.

As would be expected from inspection of Table VII, a highly significant difference in litter size existed between the control and experimental sows. The interaction between sows and groups could not be removed, but simple analyses of the data from each group revealed a highly significant variation between sows on the experimental ration and an insignificant difference between sows on the control (see Appendix Tables VIII and IX). The high variability is indicative of some adverse influence affecting litter size.

With respect to the average number of pigs weaned per litter, Series A and B may be considered together, since no significant difference existed in the weaning records of the experimental lots for the two series (t for unpaired differences = 0.42). An analysis of variance for the average number of pigs weaned per litter is presented in Table X.

TABLE X

Analysis of Variance
for Average Numbers of Pigs Weaned

Variance due to	D.F.	Sum of Squares	Variance	F	5%	1%
Between sows	22	114.30	5.20	0.67	1.93	2.58
Between groups	1	154.59	154.59	19.82**	4.06	7.24
Within sows	43	335.29	7.80			
All causes	66	604.18				

**Significant beyond the 1% point.

This analysis indicates that there was a highly significant difference between the control and experimental groups as measured by the number of pigs weaned per litter. In neither lot was there a significant difference between sows, largely because of the

extensive variation in the number of pigs weaned between successive litters of the same sow, which was used as a measure of error (see Appendix Tables X and XI).

The Effect of the Experimental Regime on Successive Generations

The repercussions of continuous feeding of the experimental ration as reflected in the farrowing and weaning performances of successive generations are represented in the results shown in Table XI.

TABLE XI

Farrowing and Weaning Record
- First vs. Second Generation

No. litters farrowed	No. pigs born alive		No. weaned		% Weaned
	Total	Mean	Total	Mean	
Control group - first generation					
17	193	11.3	137	8.1	71
Control group - second generation					
7	68	9.7	53	7.6	78
Experimental group - first generation - Series A					
17	161	9.5	87	5.1	54
Experimental group - second generation - Series A					
7	39	5.6	23	3.3	59

The effect of the experimental regime on the second generation sows may be gauged by comparing the decrease in litter size between the two generations of the test sows with

that of the control sows. The difference for the control sows is assumed to be due to the natural decrease among first litters.

On the basis of their two initial litters, the second generation sows showed a decline in litter size of 1.6 pigs for the control group and 3.9 for the experimental. The average difference between the two groups increased from 1.8 pigs in the first generation to 3.1 in the second, indicating that the adverse effects of the experimental ration were more pronounced in the F_1 generation. It is apparent from the weaning record of the latter that continuation of the experimental regime led to a deterioration of the reproductive efficiency to a point representing economic disaster for a large-scale swine producer.

Loss of Weight During Lactation

Weights of sows were recorded prior to farrowing and at weaning. The average loss of weight during this period was 58 lbs. for the control sows and 45 lbs. for the experimental, although the test sows consumed approximately three lbs. less feed daily. A fraction of this inter-group difference between average pre-farrowing and post-lactation weights may be accounted for by the difference in the average weight of the litters born (27.5 lbs. for the control group; 22.4 lbs. for the experimental) but it appears to be more closely associated with the respective numbers of pigs weaned. In the few instances when average-sized litters were weaned by experimental sows, the losses in weight were greater, comparatively, than among the control sows which weaned litters of similar size.

SECTION II. PROGENY FEEDING TRIALS.

Five feeding trials (nos. 208, 208B, 215, 218 and 221), comprised of from one to three comparable lots of pigs from each of the control and experimental groups of sows, were conducted from the summer of 1945 to the summer of 1947.

Object of Experiments

To augment the reproduction data which have been presented in Section I, feeding trials were conducted to ascertain the effect of the ration fed to the dam during gestation and lactation upon the growing and fattening performance of the progeny.

Procedure

Representative weanling pigs from each group of sows were allotted uniformly, where possible, with respect to sex, weight, dam, condition and type, to lots of five to seven pigs each. Corresponding lots of pigs from control and experimental sows were housed in drylot with straw as bedding. Minor variations in management existed from one trial to another, but management practices for lots under comparison in any one trial were the same. Weights of individual pigs were recorded at the beginning of the experiment and every fourteen days thereafter until the pigs attained market weight.

Rations

The feeding period was divided into two sections:

(1) from weaning weight to 110 lbs.

(2) from 110 lbs. to market weight.

First period ration:

Oats	35
Barley	53
Mixed supplement*	12
	100

Second period ration:

Oats	10
Barley	84
Mixed supplement*	6
	100

*Mixed supplement:

Tankage	40
Linseed oil meal	35
Fish meal	15
Ground limestone	5
Salt, iodized	5
	100

The pigs were hand-fed three times daily during the first period and twice daily during the second. The meal was slopped with water at feeding time and feed records were maintained throughout the feeding trials.

The average protein values for the above rations were 14.4% for the first period and 12.4% for the second. It will be noted that the rations for both periods were deficient in vitamins A and D. For purposes of comparison, the two lots of Experiment #221 and the first and third lots of Experiment #218, control and experimental, were given fish oil (1500A - 200D) at a rate of 4 c.c. per pig per day.

Testing

The testing period was divided into two individual

(1) Time wasting actions to kill 1st.

(2) Time kill 1st. to market waiver.

First period testing:

Date	1st
Replay	2nd
Hired assignments	3rd
	100

Second period testing:

Race	1st
Replay	2nd
Hired assignments	3rd
	100

Hired assignments:

Insurance	1st
Linseed oil treat	2nd
Club meal	3rd
Grocer Discounts	4th
Jail. Janitor	5th
	100

The plan were read-led three times daily during the first period and every daily testing for record. The testing stopped with water at testing time and Fuel measure were obtained throughout the testing period.

The weekday pasture values for the above relations are 15.4% for the first period and 13.4% for the second. It will be noted that the values for both periods were derived in element A and B. For instances or comparison, the time date of Assignment and the first one taken as assignment 1st, control and expenditure, were given fish oil (Iodine - 3000) at a rate of 1 c.c. per pig per day.

For two feeding trials, #218 and #221, the composition of the mixed supplement was amended because of a difficulty in procuring fish meal. The fish meal content was consequently reduced to 5% and the tankage increased to 50% of the supplement. The final mixture contained 36.4% crude protein by analysis.

Results and Discussion

In several instances the numbers of pigs available at one time from the experimental group of sows were so limited that it was necessary to employ a whole litter as a test lot, thereby rendering individual lot comparisons invalid. However, continued repetition of the feeding trials resulted in the establishment of lot averages which permitted the comparison of growth and fattening performances of pigs from the respective groups of sows.

A summary of the results of five comparative feeding trials is presented in Table XII.

TABLE XII

Results of Feeding Trials -
Control vs. Experimental Pigs.

Group	Lot No.	No. of pigs	Av. initial weight	Av. final weight	Av. daily gain	Av. feed consumed per 100 lbs. gain
						lbs.
Experiment #208						
Control	1	6	29.2	195.3	1.23	369.0
Experimental	1	6	29.3	193.3	1.05	400.5
Experiment #208B						
Control	1	7	42.4	202.6	1.43	378.2
Experimental	1	5	36.3	201.4	1.31	397.9
Control	2	9	26.1	194.6	1.29	369.2
Experimental	2	6	24.2	194.7	1.24	381.6
Experiment #215						
Control	1	7	35.3	200.4	1.12	378.6
Experimental	1	5	34.0	194.6	1.05	416.1
Control	2	5	29.8	199.2	1.16	391.6
Experimental	2	6	27.0	201.2	1.11	365.0
Experiment #218						
Control	1	7	24.4	194.3	1.07	367.4
Experimental	1	5	21.0	189.6	1.04	381.1
Control	2	6	34.3	209.2	1.20	375.2
Experimental	2	7	31.1	194.3	1.01	420.0
Control	3	7	39.4	201.1	1.16	380.2
Experimental	3	5	42.2	202.2	1.22	408.6
Experiment #221						
Control	1	5	45.4	200.8	1.37	377.9
Experimental	1	5	24.8	195.6	1.20	387.9
Totals and Averages						
Control		59	33.6	199.4	1.22	375.7
Experimental		50	29.8	196.2	1.13	395.6

Although the differences between the feed lot performances of the pigs from the control and the experimental sows were small, they were relatively consistent, and the average differences of 0.09 lbs. per day in daily gain and of 19.9 lbs. feed consumed per 100 lbs. gain between the two groups were highly significant

Table II

Results of Feeding Trials -
Control vs. Experimental Lots.

Group	No. of Lots	No. of Birds	Av. Initial Weight	Av. Final Weight	Feed Consumed per Lb. Gain	No. Dead
Experiment #108						
Control	2	50	1.6 oz.	1.7 lbs.	1.63	0
Experimental	2	50	1.6 oz.	1.7 lbs.	1.6	0
Experiment #206						
Control	2	50	1.6 oz.	1.7 lbs.	1.64	0
Experimental	2	50	1.6 oz.	1.7 lbs.	1.61	0
Control	2	50	1.6 oz.	1.7 lbs.	1.6	0
Experimental	2	50	1.6 oz.	1.7 lbs.	1.6	0
Experiment #209						
Control	2	50	1.6 oz.	1.7 lbs.	1.65	0
Experimental	2	50	1.6 oz.	1.7 lbs.	1.65	0
Control	2	50	1.6 oz.	1.7 lbs.	1.67	0
Experimental	2	50	1.6 oz.	1.7 lbs.	1.71	0
Experiment #213						
Control	2	50	1.6 oz.	1.7 lbs.	1.70	0
Experimental	2	50	1.6 oz.	1.7 lbs.	1.68	0
Control 2%	2	50	1.6 oz.	1.7 lbs.	1.67	0
Experimental	2	50	1.6 oz.	1.7 lbs.	1.7	0
Control	2	50	1.6 oz.	1.7 lbs.	1.69	0
Experimental	2	50	1.6 oz.	1.7 lbs.	1.67	0
Experiment #217						
Control	2	50	1.6 oz.	1.7 lbs.	1.67	0
Experimental	2	50	1.6 oz.	1.7 lbs.	1.65	0
Totals and Averages						
Control	50	500	1.6 oz.	1.7 lbs.	1.67	0
Experimental	50	500	1.6 oz.	1.7 lbs.	1.64	0

Although the differences between the feed lot performance of the Alum Clay and the Control and the Experimental Lots were relatively insignificant, and the maximum difference of 0.06 lbs. per bag in daily gain was of 11.0 lbs. feed consumed per 100 lbs. only whereas the Control group lost 1.0 lbs.

according to Student's t test for unpaired values (t = 19.83 and 3.67 respectively).

In Table XIII the control and experimental groups of sows are compared on the basis of the numbers of pigs marketed and their ages at market weight for all experiments.

TABLE XIII

Summary of Marketing Record -
Control vs. Experimental Pigs.

Group	No. litters	No. pigs weaned	% weaned	No. pigs marketed	% marketed	% loss between weaning & marketing	Av. age at market weight (days)
Control	34	263	69	230	61	12	217*
Experimental	33	155	54	118	41	24	219**

* Basis 137 pigs whose ages were recorded at market weight (200 - 210 lbs.)
**Basis 76 pigs whose ages were recorded at market weight.

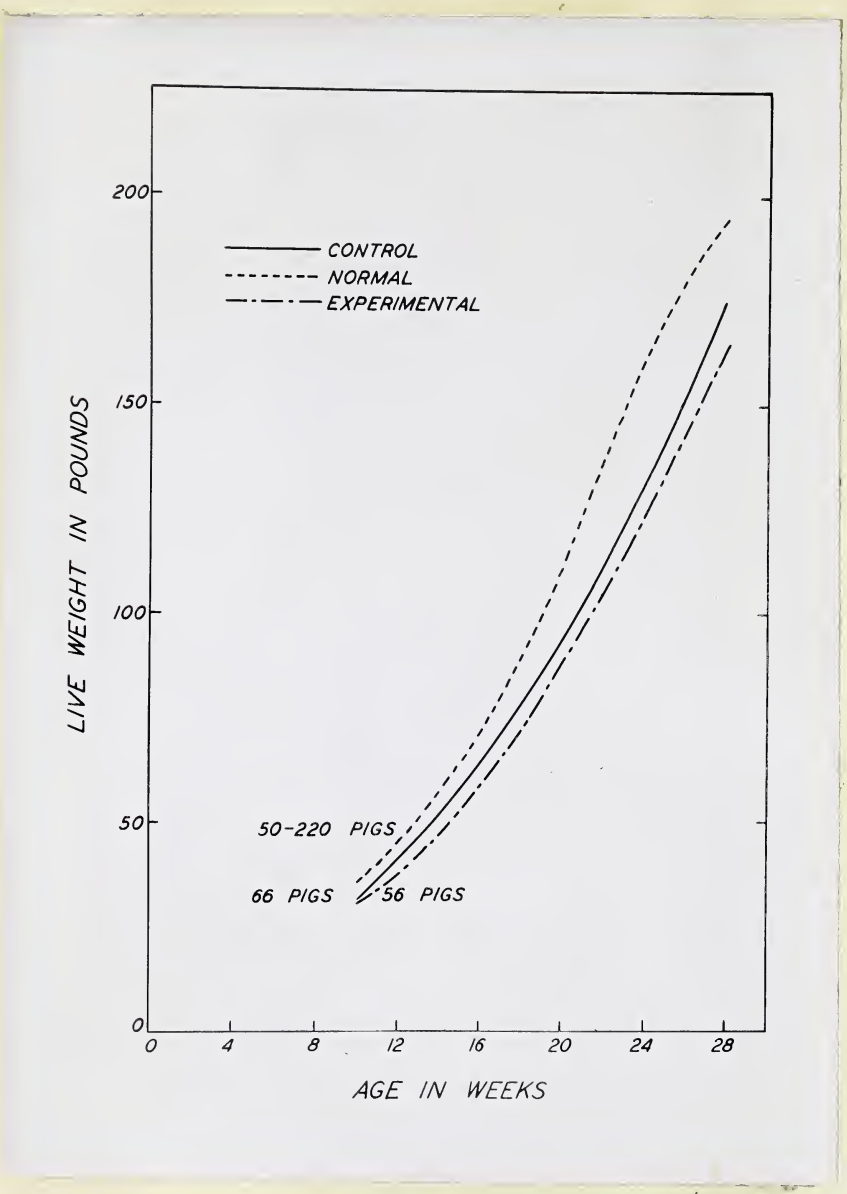

FIGURE I

Live Weights of Control and Experimental Pigs from Birth to 28 Weeks of Age.

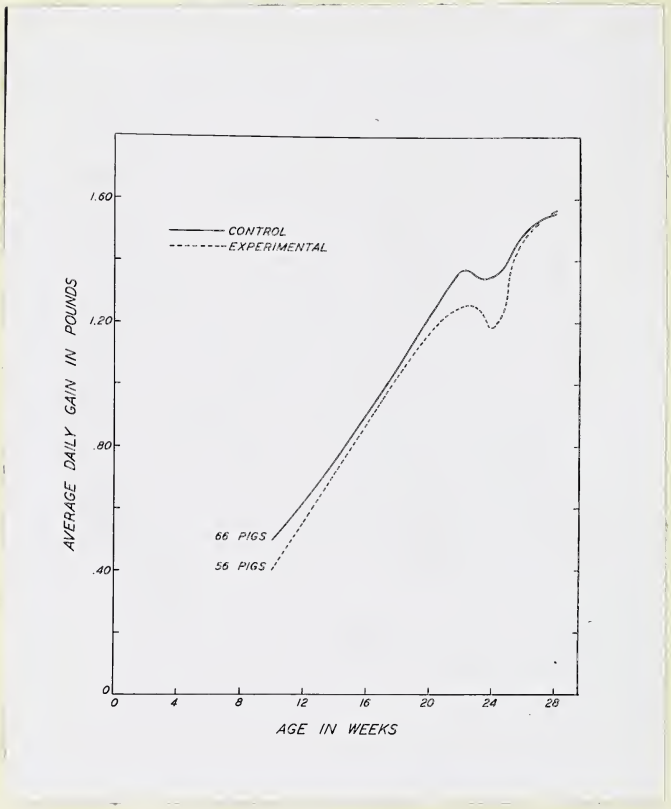

FIGURE II

Average Daily Gains of Control and Experimental Pigs from Birth to 28 Weeks of Age.

The average weights of the control and experimental pigs from 10 to 28 weeks of age are shown graphically in Figure I. For comparison, an estimated "normal" growth curve for Yorkshire pigs as established by Crampton (23) is also plotted. The curves reveal a slight but consistent difference in favor of the control pigs as compared to the experimental ones, though both groups were significantly lighter throughout the period than those comprising the standard. This discrepancy may be due to a strain difference, a more favorable nutritional regime or other environmental factors, but in any case the performance of both groups of pigs must be considered somewhat subnormal.

Average daily gains of the pigs during the same period are indicated in Figure II. The mean growth rate of the control pigs was consistently greater, but large variations occurred in both groups. The depressions in the curves at about the twenty-second week were presumably caused by a change in the composition of the ration from Period I to Period II which occurred at this time. A decreased slope at the upper extremity of the curves was due to the marketing of the fastest gaining pigs. The average daily gains for the control and experimental groups respectively were .99 lbs. and .92 lbs. during Period I and 1.54 lbs. and 1.44 lbs. during Period II.

Occasional cases of staggering and muscular incoordination occurred among the growing pigs of both groups. These pigs responded to the administration of fish oil and the attacks were therefore attributed to vitamin A deficiency. However,

no drastic symptom of a deficiency of this vitamin, such as blindness, was observed. The ration for the two lots of Experiment #221 and for the first and third lots of Experiment #218, control and experimental, contained fish oil (1500A - 200D) at a level of 4 c.c. per pig per day. The feeding oil produced no significant increase in the rate of gain, though no cases of incoordination were observed in these lots.

The practical significance of the discrepancy between the control and experimental groups of sows is represented by the respective numbers of pigs marketed, namely 230 as compared to 118. The total losses from farrowing to marketing were 39% for the control group and 59% for the experimental. For the pigs remaining, however, the variability, as measured by the criteria of average daily gain and feed consumption per unit gain, was less striking. In other words, the effect of the deficient ration fed to the experimental sows was exemplified primarily in the reproduction and weaning performance rather than in the growing-fattening performance of the progeny.

GENERAL DISCUSSION - SECTIONS I AND II.

The prolonged maintenance of sows on the unbalanced experimental ration used in these experiments resulted in a decrease in the reproductive efficiency as compared to that of the control animals, but considering the apparent deficiencies in protein, vitamin D and particularly vitamin A, the results were in some respects unexpectedly favorable. Evidently no factors were deficient to such a degree that the ability of the sows to conceive was affected. However, their prolificacy was significantly reduced, as is apparent from the average difference of 2.7 live pigs born per litter between the experimental and control groups of Series A. Apart from size of litter, no impairment of the reproductive function seems to have occurred up to the lactation period. The incidence of abnormalities was zero, the number of pigs born dead was the same for the two groups, and the average birth weight of the test pigs was 0.2 lbs. greater than that of the controls.

In view of the continued absence of a vitamin A supplement in the experimental ration, it is surprising that no gross evidence of a deficiency of this vitamin occurred in the performance of the sows. Although small litters were farrowed and many of the young pigs possessed low viability, the expected high incidence of mortality and malformations at birth was not encountered. In this connection there was, unfortunately, no attempt made to determine whether the undersized litters were

due to a low production of ova or to the death and resorption of some of the fetuses.

The main impact of the deficient regime was observed during the lactation period. Many of the test pigs became thin, emaciated and diarrhoeic within a few days after birth, and the incidence of mortality reached 45% at weaning age. The hardship of weaning and the change of feed was sufficient to cause the death of 24% of the remaining pigs shortly after weaning. Those that survived to 12 weeks of age were, in the main, of fair vigor, and they put on weight at a rate approaching that of progeny of the control sows.

What proportion of the losses which occurred during lactation was due to a deficiency of vital factors in the milk of the experimental sows and what proportion was caused by an inadequate storage of factors in the fetuses is speculative. It is also impossible to state with assurance to what extent a quantitative deficiency of milk existed on the part of these sows, but it is doubtful that there was a shortage during early lactation. Many of the young pigs were lacking in vigor and failed to suckle adequately. Whether from a dietary cause or from insufficient suckling, the milk supply of some of the sows became quite meagre during the late stages of lactation.

The incidence of secondary infections, particularly those of the respiratory tract, was high, and this situation was aggravated, especially during the winter months, by the housing conditions which prevailed.

The addition of alfalfa to the ration of the experimental sows produced one positive effect, namely an increase in litter size at birth. The losses between birth and weaning were not reduced, however, and by market age 62% of the pigs born alive had died. Obviously the therapeutic value of alfalfa in this ration was in marked contrast to its value in the corn-soybean diet as reported by several workers. It appears either that the factors deficient in the experimental ration were not the ones deficient in the corn-soybean ration or that the experimental sows were irremediably affected by continuous subjection to the inadequate regime of Series A. There is no report in the literature concerning the value of alfalfa supplementation of a corn-soybean ration for sows which had been previously maintained on the basal mixture for a period comparable to that of the duration of the Series A experiments.

The cumulative ~~residual~~ effect of the experimental regime is apparent from the fact that the difference in litter size between the first and second generations was 2.3 pigs greater for the test group than for the controls. The average litter size for the seven second generation experimental sows of Series A was only 5.6 pigs.

An attempt was made to assess the economic significance of the discrepancy between the control and experimental groups during the period of these experiments. The gross revenue accruing from the sale of the progeny was calculated at current prices on a B_1 carcass grade basis. The feed consumption data for the pigs used in the feeding trials were applied to those

for which no records were maintained, and similarly the feed consumption of from seven to eighteen sows at different periods was assumed to be an average for the entire group. The cost estimates, apart from those for feed, were based on the University of Alberta method for computing hog production costs (31). Feed costs were calculated from prices prevailing at the time of the experiments. A qualified financial statement is presented in Table XIV and a breakdown of the cost data is given in Appendix Tables XII and XIII.

TABLE XIV

Financial Statement -
Control vs. Experimental Groups.

	Control		Experimental	
Revenue				
Gross revenue from sale of pigs		$6667		$3392
Liabilities				
Feed cost (sows)	$1038		$ 729	
Feed cost (pigs)	2355		1284	
Labor @ $4 per pig	920		472	
Depreciation - sow replacement, buildings, fences, etc. ($2 per pig)	460		236	
Incidentals - boar service, feed grinding, marketing costs, etc. ($2 per pig)	460		236	
Interest on investment ($1.25 per pig)	287		147	
Total liabilities		$5520	$	$3104
Net profit		$1147		$ 288

The calculated difference in net profit of $859 is considered conservative. The charges levied against the experimental group for sow replacement, boar service and depreciation on buildings are relatively small, and in addition the feeding performance of the experimental pigs used in the feeding trials, upon which the feed cost estimates were based, is believed to be considerably better than the average for the whole group. In any event, the net profit estimate emphasizes the practical value of a system of brood sow management based on the use of reasonably well-balanced rations including pasture in season, as compared to a system of drylot feeding of coarse grains supplemented with only iodized salt and ground limestone.

SUMMARY AND CONCLUSIONS

Experiments were conducted to observe the effects of maintaining an experimental group of sows on a ration consisting of small grains, iodized salt and ground limestone, a ration which was deficient in protein plus vitamins A and D and was devoid of green feed, as compared to the effects of maintaining a control group on a common practical ration which included coarse grains, mixed supplement and pasture in season. The results of these tests are summarized as follows:

1. The breeding efficiency of the experimental sows as measured by their ability to conceive was not impaired by the deficient ration.
2. The prolificacy of the test sows was reduced by 2.7 live pigs per litter as compared to the control group.
3. Sows maintained on the drylot ration were unable to adequately provide for the nutritional requirements of their litters during lactation. Pig mortality was high during lactation and for a period of about four weeks following weaning.
4. The addition of alfalfa to the deficient ration caused an increase in the average number of live pigs farrowed but failed to provide the missing factors required for successful lactation.
5. The deleterious effects of the experimental group ration were more pronounced in the reproduction performance of the second generation test sows than in that of their dams.
6. The progeny of the experimental sows which survived the lactation and early post-weaning periods gained at a rate almost equivalent to that of the progeny of the control sows, and required approximately 5% more feed per 100 lbs. gain.
7. The estimated difference between the net profits accruing from the control and experimental groups during a period of three and one-half years or seven farrowing seasons was eight hundred and fifty-nine dollars in favor of the group fed the supplemented ration with pasture in season.

REFERENCES

1. MORRISON, F.B., FARGO, J.M. and BOHSTEDT, G. Feed and Care of the Brood Sow and Litter. Wis. Agr. Expt. Sta. Bul. 400, 1928.

2. MARTIN, E. Hay and Pasture for Sows during Gestation and Lactation. Ark. Agr. Expt. Sta. Bul. 336, 1936.

3. GARDNER, V.R. Alfalfa vs. Tankage for Breeding Gilts. Mich. Agr. Expt. Sta. Rpt. 1932.

4. FREEMAN, V.A. Ground Alfalfa vs. Tankage for Sows. Mich. Agr. Expt. Sta. Quar. Bul. 21, 91, 1938.

5. FREEMAN, V.A. Ground Alfalfa for Brood Sows. Mich. Agr. Expt. Sta. Quar. Bul. 25, 148, 1942.

6. HOGAN, A.G. Swine Reproduction in Relation to Nutrition. Mo. Agr. Expt. Sta. Res. Bul. 168, 1932.

7. HOGAN, A.G. and JOHNSON, S.R. Best Rations for Brood Sows. Mo. Agr. Expt. Sta. Bul. 340, 7, 1933.

8. HOGAN, A.G. and JOHNSON, S.R. Inadequacy of the Concentrates Commonly Used in Swine Feeding. Mo. Agr. Expt. Sta. Res. Bul. 321, 1940.

9. HOGAN, A.G. and JOHNSON, S.R. Supplementary Value of Various Feedstuffs in Brood Sow Rations. Mo. Agr. Expt. Sta. Res. Bul. 332, 1, 1941.

10. HOGAN, A.G. and JOHNSON, S.R. Good Pastures Improve the Pig Crop. Mo. Agr. Expt. Sta. Cir. 187, 1935.

11. HOGAN, A.G., JOHNSON, S.R. and GAHLEY, E.G. Ration of Brood Sow and Response of Suckling Pigs. Proc. Am. Soc. An. Prod., 112, 1938.

12. HOGAN, A.G. and McROBERTS, V.F. Vitamin Deficiencies in a Ration for Brood Sows. Proc. Am. Soc. An. Prod., 139, 1940.

13. ROSS, O.B., PHILLIPS, P.H. and BOHSTEDT, G. The Effect of a Simplified Diet on Reproduction and Lactation in Swine and in the Rat. J. Animal Sci. 1, 86, 1942.

14. ROSS, O.B., PHILLIPS, P.H. and BOHSTEDT, G. The Effect of Diet on Brood Sow Performance. J. Animal Sci. 1, 353, 1942.

1. [illegible], E.J., [illegible], J.E., and [illegible], T. [illegible] and [illegible] of the Speed and Elbow. [illegible]. [illegible]. [illegible]. [illegible]. [illegible], 1959.

2. [illegible], T. [illegible] for Some Testing Materials and Lubrication. [illegible]. [illegible]. [illegible]. [illegible]. [illegible], 1959.

3. [illegible], V.E. Criteria Vs. Tensile for Testing Alloys. [illegible]. [illegible]. [illegible]. [illegible], 1959.

4. [illegible], T.A. Cooling Affects Vs. Hardness for Wear. [illegible]. [illegible]. [illegible]. [illegible], 1959.

5. [illegible], T.A. Optimum Affects for Speed [illegible]. [illegible]. [illegible]. [illegible]. [illegible], 1959.

6. [illegible], A.D. Swine Reproduction in Relation to Nutrition. [illegible]. [illegible]. [illegible]. [illegible], 1959.

7. [illegible], A.D. and [illegible], S.S. Seed Varieties for Dense Cane. [illegible]. [illegible]. [illegible]. [illegible], 1959.

8. [illegible], A.A. and [illegible], S.D. Discussion of the Commercial Used in Swine Feeding. [illegible]. [illegible]. [illegible]. [illegible], 1959.

9. [illegible], A.D. and [illegible], A.A. Supplementary Value of Various Roughages in Brood Sow Feeding. [illegible]. [illegible]. [illegible]. [illegible], 1959.

10. [illegible], A.T. and [illegible], D.E. Seed Storage During the Pig Crop. [illegible]. [illegible]. [illegible], 1959.

11. [illegible], A.T., [illegible], E.W. and [illegible], T. Testing of Wood Ash and Response of Growing Pigs. [illegible]. [illegible]. [illegible]. [illegible], 1959.

12. [illegible], A.D. and [illegible], T. Fibrosis Differentiation for a Period for Brood Sows. [illegible]. [illegible]. [illegible], 1959.

13. [illegible], D., [illegible], T.E. and [illegible], T. [illegible] a Simplified List on Reproduction and Lactation in Swine and in the [illegible]. [illegible]. [illegible], 1959.

14. [illegible], D.E., [illegible], T.E. and [illegible], T. [illegible] Used in Two Periods for Fattening. [illegible]. [illegible], 1959.

15. CUNHA, T.J., ROSS, O.B., PHILLIPS, P.H. and BOHSTEDT, G. Further Observations on the Dietary Insufficiency of a Corn-Soybean Ration for Reproduction in Swine. J. Animal Sci. 3, 415, 1944.

16. KRIDER, J.L., FAIRBANKS, B.W. and CARROLL, W.E. Distillers' By-products in Swine Rations. J. Animal Sci. 3, 107, 1944.

17. KRIDER, J.L., FAIRBANKS, B.W. and CARROLL, W.E. Effect of Diet on Gestation and Lactation Performance. J. Animal Sci. 3, 447, 1944.

18. FAIRBANKS, B.W., KRIDER, J.L. and CARROLL, W.E. Effect of Diet on Gestation-Lactation Performance of Sows. J. Animal Sci. 4, 410, 1945.

19. KRIDER, J.L., FAIRBANKS, B.W., VAN POUCKE, R.F., BECKER, D.E. and CARROLL, W.E. Sardine Condensed Fish Solubles and Rye Pasture for Sows during Gestation and Lactation. J. Animal Sci. 5, 256, 1946.

20. KRIDER, J.L., BECKER, D.E. and CARROLL, W.E. Rye Pasture, Fish Solubles and Alfalfa Meal Compared in Brood Sow Rations. J. Animal Sci. 5, 419, 1946.

21. KRIDER, J.L., VAN POUCKE, R.F., BECKER, D.E. and CARROLL, W.E. Preliminary Studies on Supplementing a Ration for Brood Sows with Folic Acid, Vitamins and Vitamin Concentrates. J. Animal Sci. 5, 406, 1946.

22. ENSMINGER, M.E., BOWLAND, J.P. and CUNHA, T.J. Observations on the Thiamin, Riboflavin and Choline Needs of Sows for Reproduction. J. Animal Sci. 6, 409, 1947.

23. CRAMPTON, E.W. Growth and Feed Consumption of Bacon Hogs. Sci. Agr. 19, 736, 1939.

24. JOHNSON, E.L., CARRICK, C.W., ROBERTS, R.E. and HAUGE, S.M. Evidence of New Growth Factors for Chicks. Poultry Sci. 21, 566, 1942.

25. SYNOLD, R.E., CARRICK, C.W., ROBERTS, R.E. and HAUGE, S.M. Distillers' Dried Solubles as a Vitamin Supplement in Chick Rations. Poultry Sci. 22, 323, 1943.

26. NOVAK, A.F., HAUGE, S.M. and CARRICK, C.W. An Unidentified Growth Factor in Distillers' Dried Solubles Essential for the Chick. Poultry Sci. 26, 604, 1947.

27. RUBIN, M. and BIRD , H.R. A Chick Growth Factor in Cow Manure. J. Biol. Chem. 163, 1946.

28. MORRISON, F.B., Feeds and Feeding, 20th ed. 1946.

29. Recommended Nutrient Allowances for Swine. Report of the Committee on Animal Nutrition. National Research Council, Washington, D.C. August, 1944.

30. HOGAN, A.G. The Calcium Requirement of Brood Sows. Mo. Agr. Expt. Sta. Res. Bul. 167, 1932.

31. Agricultural Information. Alberta Department of Agriculture. Office of Information. Issue No. 8, 1943.

APPENDIX TABLES

TABLE I

Reproduction Record - Control vs. Experimental Sows - Experiment #200

Group	Sows Farrowed	No. pigs born Alive	Dead	Av. birth weight	No. weaned	% weaned	Av. weaning weight	No. marketed	% marketed
Control	144W	10	-	3.4	7	70	32.1	7	70
	315W	14	1	2.5	9	64	24.6	4	29
	175W	14	-	2.7	12	86	25.2	11	79
Total	3*	38	1	-	28	74	-	22	58
Average	3	12.7	0.3	2.8	9.3	74	26.7	7.3	58
Experimental	279W	9	1	2.5	9	100	21.1	7	78
	261W	9	-	3.0	7	78	22.9	5	56
	129W	10	-	2.5	5	50	25.8	2	20
	90W	12	-	2.1	3	25	24.7	2	17
Total	4	40	1	-	24	60	-	16	40
Average	4	10.0	0.3	2.5	6.0	60	23.1	4.0	40

*Sow 73W aborted on the 88th day of gestation.

TABLE II

Reproduction Record - Control vs. Experimental Sows - Experiment #200B

Group	Sows Farrowed	No. pigs born Alive	Dead	Av. birth weight	No. weaned	% weaned	Av. weaning weight	No. marketed	% marketed
Control	144W	13	-	2.4	13	100	31.7	13	100
	73W	10	2	2.5	8	80	26.9	7	70
	315W	13	-	2.5	9	69	25.1	6	46
	175W	12	-	2.5	11	92	26.4	11	92
Total	4	48	2	-	41	85	-	37	77
Average	4	12.0	0.5	2.5	10.3	85	27.9	9.3	77
Experimental	279W	11	-	-	4	37	23.5	3	27
	261W	9	1	2.6	7	78	23.4	4	44
	90W	7	1	2.8	6	86	23.8	6	86
Total	3*	27	2	-	17	63	-	13	48
Average	3	9.0	0.7	2.7	5.7	63	23.6	4.3	48

*Sow 129W failed to conceive.

TABLE III

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE III

Reproduction Record - Control vs. Experimental Sows - Experiment #208

Group	Sows Farrowed	No. pigs born Alive	Dead	Av. birth weight	No. weaned	% weaned	Av. weaning weight	No. marketed	% marketed
Control	73W	13	-	2.5	4	31	30.5	4	31
	315W	9	2	2.7	8	89	22.8	8	89
	175W	11	-	2.1	7	64	19.1	5	46
Total	3*	33	2	-	19	58	-	17	52
Average	3	11.0	0.7	2.5	6.3	58	23.1	5.7	52
Experimental	279W	9	-	2.7	2	22	20.5	2	22
	261W	10	-	2.5	5	50	21.2	5	50
	129W	9	-	2.9	4	44	22.0	4	44
	90W	10	-	2.5	0	0	-	0	0
Total	4	39	-	-	11	29	-	11	29
Average	4	9.5	-	2.6	2.8	29	21.4	2.8	29

*Sow 144W aborted on the 58th day of gestation.

TABLE IV

Reproduction Record - Control vs. Experimental Sows - Experiment #208B

Group	Sows Farrowed	No. pigs born Alive	Dead	Av. birth weight	No. weaned	% weaned	Av. weaning weight	No. marketed	% marketed
Control	175W	12	-	2.3	7	58	28.6	7	58
	144W	12	-	2.3	7	58	26.1	7	58
	73W	8	-	3.0	8	100	20.0	7	88
	315W	9	3	2.0	5	42	26.8	4	33
	201Z	8	-	2.1	7	88	20.7	7	88
	63Z	3	1	3.0	3	100	37.7	3	100
	198Z	9	-	2.9	5	56	31.4	4	44
Total	7	61	4	-	42	69	-	39	64
Average	7	8.7	0.6	2.4	6.0	69	26.0	5.6	64
Experimental	129W	8	-	2.5	4	56	30.8	4	44
	90W	8	-	2.6	5	63	34.2	5	63
	279W	11	-	3.1	7	64	27.8	6	55
	261W	10	-	2.9	5	50	35.4	4	40
	72Z	4	3	3.0	4	100	27.5	4	100
	169Z	8	-	2.5	6	75	26.7	5	63
	170Z	3	1	2.2	3	75	33.3	1	25
Total	7	52	4	-	34	65	-	29	56
Average	7	7.4	0.6	2.7	4.9	65	30.5	4.1	56

TABLE V

Reproduction Record - Control vs. Experimental Sows - Experiment #215

Group	Sows Farrowed	No. pigs born Alive	Dead	Av. birth weight	No. weaned	% weaned	Av. weaning weight	No. marketed	% marketed
Control	306Z	10	-	2.8	9	90	24.9	8	80
	201Z	11	-	2.5	11	100	-	9	82
	63Z	15	-	2.1	8	53	29.4	8	53
	198Z	12	-	2.8	10	83	19.8	10	83
	175W	14	-	2.0	12	86	24.4	7	50
Total	5*	62	-	-	50	81	-	42	68
Average	5	12.4	-	2.4	10.0	81	24.4	8.4	68
Experimental	315Z	1	2	2.7	0	0	-	0	0
	314Z	7	-	2.4	5	71	28.0	4	57
	129W	11	-	3.1	7	64	37.4	2	18
	169Z	9	-	2.9	3	33	20.3	3	33
	90W	8	1	2.8	7	88	30.0	7	88
	170Z	7	-	2.7	2	29	18.0	1	14
Total	6	43	3	-	24	56	-	17	40
Average	6	7.2	0.5	2.8	4.0	56	29.5	2.8	40

*Sow 303Z failed to conceive.

TABLE VI

Reproduction Record - Control vs. Experimental Sows - Experiment #218

Group	Sows Farrowed	No. pigs born Alive	Dead	Av. birth weight	No. weaned	% weaned	Av. weaning weight	No. marketed	% marketed
Control	306Z	12	-	3.0	8	67	-	8	67
	201Z	11	-	2.4	11	100	26.4	11	100
	63Z	16	6	2.0	2	13	32.5	2	13
	73W	11	3	2.8	4	36	33.5	4	36
	175W	8	-	2.6	6	75	28.3	6	75
	198Z	9	-	3.1	6	67	34.8	6	67
	74A	10	-	2.6	6	60	22.0	5	50
Total	7*	77	9	-	43	56	-	42	55
Average	7.	11.0	1.3	2.6	6.1	56	28.6	6.0	55
Experimental	104A	10	-	2.7	6	60	21.5	6	60
	170Z	8	-	2.4	2	25	34.0	2	25
	314Z	9	2	2.0	0	0	-	0	0
	315Z	8	4	2.5	2	25	21.5	1	13
	105A	11	-	2.5	7	64	20.6	6	55
Total	5	46	6	-	17	37	-	15	33
Average	5	9.2	1.2	2.4	3.4	37	22.6	3.0	33

*Sow 393Z failed to conceive.

TABLE VII

Reproduction Record - Control vs. Experimental Sows - Experiment #221

Group	Sows Farrowed	No. pigs born Alive	Dead	Av. birth weight	No. weaned	% weaned	Av. weaning weight	No. marketed	% marketed
Control	306Z	13	-	3.3	10	77	28.8	9	69
	201Z	13	-	2.7	8	62	22.6	7	54
	82A	10	-	3.3	4	40	17.5	1	10
	63Z	13	-	2.3	10	77	19.5	8	62
	241A	11	-	2.5	8	73	18.4	6	55
Total	5	60	-	-	40	67	-	31	52
Average	5	12.0	-	2.8	8.0	67	22.0	6.2	52
Experimental	314Z	11	-	2.5	9	82	15.8	7	64
	170Z	9	1	3.5	5	56	23.0	4	44
	169Z	10	-	2.8	4	40	26.5	3	30
	312A	10	-	2.5	10	100	13.8	4	40
Total	4	40	1	-	38	70	-	18	45
Average	4	10.0	0.3	2.8	7.0	70	17.9	4.5	45

TABLE VIII

Analysis of Variance for Litter Size
- Control Group.

Variance due to	D.F.	Sum of Squares	Variance	F	5%	1%
Between Sows	10	14.84	1.38	0.16	2.74	4.33
Between Litters	23	193.42	8.41			
Total	33	208.26				

TABLE IX

Analysis of Variance for Litter Size
- Experimental Group

Variance due to	D.F.	Sum of Squares	Variance	F	5%	1%
Between Sows	8	120.83	15.10	6.56**	2.64	4.00
Between Litters	15	34.50	2.30			
Total	23	155.33				

**Significant beyond the 1% point.

Table VIII

Analysis of Variance for Sitter Area
- Control Group.

Variance due to	d.f.	Sum of Squares	Mean Square	F	P	Sig.
Between Rows	10	61.03	6.10	0.19	2.0%	n.s.
Between Columns	13	324.42	5.00			
Total	23	385.45				

Table IX

Analysis of Variance for Sitter Area
- Experimental Group

Variance due to	d.f.	Sum of Squares	Mean Square	F	P	Sig.
Between Rows	8	120.15	15.02	4.50	1.0%	n.s.
Between Columns	15	84.50	5.30			
Total	23	181.33				

Significance beyond the 1% point.

TABLE X

Analysis of Variance for
Average Numbers of Pigs Weaned
- Control Group

Variance due to	D.F.	Sum of Squares	Variance	F	5%	1%
Between Sows	10	83.50	8.35	1.18	2.28	3.21
Between Litters	23	163.08	7.09			
Total	33	246.58				

TABLE XI

Analysis of Variance for
Average Numbers of Pigs Weaned
- Experimental Group

Variance due to	D.F.	Sum of Squares	Variance	F	5%	1%
Between Sows	11	85.83	7.80	1.33	2.28	3.24
Between Litters	21	123.14	5.86			
Total	32	208.97				

TABLE XII

Average Feed and Hog Prices
- 1945 to 1948.

Item	Average Price 1945	1946	1947	1948*
Dressed Hogs - B_1 Grade (per cwt.)	$16.15	$17.40	$20.15	$26.60
Commercial Feeds (cents per lb.)				
Oats	1.53	1.35	1.65	2.12
Barley	1.35	1.21	1.46	2.29
Tankage	2.50	2.70	2.75	4.50
Linseed oil meal	2.50	2.50	2.50	4.00
Alfalfa meal	1.84	2.10	1.65	1.90
Ground limestone	0.75	0.60	0.60	0.85
Iodized salt	1.35	1.40	1.50	1.75
Fish meal	4.45	4.45	4.75	6.15
Fish oil (per c.c.)	.047	.047	.056	.070

*As of March, 1948.

TABLE XIII

Feed Costs - Control vs. Experimental
Sows and Pigs.

	Control		Experimental	
Cost of dry rations for sows (per cwt.):				
on pasture	$ 1.48		--	
in drylot (Series A)	1.53		$ 1.42	
in drylot (Series B)	1.53		1.49	
Total cost of dry rations for sows	954.		729.	
Cost of pasture ($4 per sow per year)	84.		--	
Total cost of sow rations		$1038		$729
Cost of rations for market pigs (per cwt.):				
first period	$ 1.55		$ 1.55	
second period	1.43		1.43	
Average feed cost per market pig	10.24		10.88	
Total feed cost for market pigs		$2355		$1284
Total feed cost (sows and market pigs)		$3393		$2013

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